

aminopropylethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropylmethyl dimethoxysilane and combinations thereof, based on 100 parts of the cyanate ester.

24. (AMENDED) The method of claim 13, wherein the filler is selected from the group consisting of silica, Aluminum Oxide, 92% Alumina, 96% Alumina, Aluminum Nitride, Silicon Nitride, Silicon Carbide, Beryllium Oxide, Boron Nitride and Diamond powder.

25. (AMENDED) The method of claim 13, wherein the composition further comprises a toughening agent selected from the group consisting of elastomers, rubber, epoxy terminated elastomer, hydroxy-terminated polysulfone oligomers, and combinations thereof.

26. (AMENDED) The method of claim 25, wherein a viscosity of the toughening agent includes from about 500 to about 1,000 centipoise.

REMARKS

Claims 13 - 26 are pending. Claims 13- 26 stand rejected. The Office rejected Claim 25 under 35 U.S.C. § 112, first paragraph. The Office rejected Claims 15, 16, 19-24 and 26 under 35 U.S.C. § 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The Office rejected Claims 13 - 22 under 35 U.S.C. 103(a) as being allegedly unpatentable over Christie *et al.* (5,250,848) in view of Gelorme *et al.* (5,464,726). The Office rejected Claims 13-26 under 35 U.S.C. 103(a) as being allegedly unpatentable over Christie *et al.* (5,250,848) in view of Gaku *et*

al. (4,554,346). The office rejected Claims 13-26 under the judicially created doctrine of obviousness-type double patenting as being allegedly unpatentable over claims 1-9 of U.S. Patent No. 6,129,955 in view of Christie *et al.* Applicants respectfully traverse the Examiner's rejections in the following discussion.

35 U.S.C. § 112, first paragraph

The Examiner rejected Claim 25 as unpatentable under 35 U.S.C. § 112, first paragraph, because allegedly the specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to practice the invention commensurate in scope with these claims. Applicants respectfully traverse the Examiner's rejection, maintaining the specification does enable a person skilled in the art to practice for example use of tougheners that are epoxy-terminated elastomers as claimed *inter alia* in Claim 25. For example, Applicants' disclosure states "[e]poxy resin monomers may be reacted with these materials to form an epoxy terminated elastomer that can be used as toughening agents." Applicants' disclosure, page 28, lines 13 - 14. Further, Applicants' specification discloses "elastomeric units such as elastomers or rubbers that can be used in the composition of the present invention include, but are not limited to, copolymers of styrene, butadiene, and ethylene or styrene, Applicants' disclosure, page 28, lines 7 - 12.

In light of the foregoing discussion, Applicants respectfully consider that Claim 25 is allowable under 35 U.S.C. § 112, first paragraph because Applicants' specification discloses that epoxy resin monomers may be reacted with specified materials to enable one skilled in the art to

practice the formation of “an epoxy terminated elastomer that can be used as toughening agents.”

See *supra*.

35 U.S.C. § 112, second paragraph

The Examiner rejected Claims 15, 16, 19-24 and 26 under 35 U.S.C. § 112, second paragraph. Applicants respectfully traverse the Examiner’s rejection maintaining Claims 15, 16, 19-24 and 26 as now claimed satisfy the statutory requirements of 35 U.S.C. § 112, second paragraph.

35 U.S.C. § 103(a)

The Examiner rejected Claims 13-22 under 35 U.S.C. § 103(a), as allegedly unpatentable over Christie *et al.* (5,250,848) in view of Gelorme *et al.* (5,464,726). Applicants respectfully traverse the Examiner’s rejection maintaining Christie *et al.* in view of Gelorme *et al.* fail to teach or suggest for example the treatment of a filler with surface treating agents as claimed in Applicants’ Claim 13. Christie *et al.* in view of Gelorme *et al.* do not teach or suggest for example Applicants’ Claim 13: [a] method for encapsulating a solder joint ... comprising the steps *inter alia* of: forming a composition comprising a cyanate ester, a photoinitiator, and dispersed filler, wherein the filler has been treated with a surface treating agent. Applicants’ disclosure supports the composition of Applicants’ Claims 13 stating for example, “[s]urface treating agents that may be used in this invention are, for instance, vinyltrimethoxysilane, vinyltriethoxysilane, N(2-aminoethyl)3-aminopropyl methyldimethoxysilane,

3-aminopropylethoxysilane, 3- glycidoxypopyl trimethoxysilane, 3-glycidoxypopylmethyl dimethoxysilane." Applicants' disclosure, page 24, lines 18 - 21. In contrast, Applicants respectfully assert Christie *et al.*, in view of Gelorme *et al.* do not teach or suggest for example treatment of the filler. (See Christie *et al.*, column 5, lines 3-28, and Gelorme *et al.*, column 13, lines 54 - 60, disclosing use of untreated fillers.)

In light of the foregoing discussion, Applicants respectfully assert that Claim 13, and Claims 14-22 depending therefrom are in condition for allowance under 35 U.S.C. § 103(a) because Christie *et al.* in view of Gelorme *et al.* fail to teach or suggest for example treatment of filler with surface treating agents as stated in Applicants Claim 13.

The Examiner rejected Claims 13-26 under 35 U.S.C. § 103(a) as being allegedly unpatentable over Christie *et al.* (5,250,848) in view of Gaku *et al.* (4,554,346). Applicants respectfully traverse the Examiner's rejection maintaining Christie *et al.* in view of Gelorme *et al.* fail to teach or suggest for example the treatment of the filler with surface treating agents of Applicants' Claim 13. Applicants specification excerpted *supra* supports treatment of a surface of the filler with surface treating agents. Applicants' disclosure, page 24, lines 18 - 21. In contrast, Applicants respectfully assert Christie *et al.*, in view of Gaku *et al.* do not teach or suggest for example treatment of the filler. (See Christie *et al.*, column 5, lines 8-28, and Gaku *et al.*, column 7, lines 8 - 27, disclosing use of untreated fillers.)

In light of the foregoing discussion, Applicants respectfully assert that Claim 13, and Claims 14-26 depending therefrom are in condition for allowance under 35 U.S.C. § 103(a)

because Christie *et al.* in view of Gaku *et al.* fail to teach or suggest for example treatment of filler with surface treating agents as stated in Applicants Claim 13.

In light of the foregoing discussion, Applicants respectfully consider Claim 25 is in condition for allowance under 35 U.S.C. § 112 first paragraph because Applicants' specification discloses that epoxy resin monomers may be reacted with specified materials to enable one skilled in the art to practice the formation of "an epoxy terminated elastomer that can be used as toughening agents." See *supra*. Applicants respectfully consider Claim 13 is in condition for allowance under 35 U.S.C. § 103(a) because Christie *et al.*, in view of Gelorme *et al.*, and Christie *et al.* in view of Gaku *et al.* fail to teach or suggest treatment of the filler using surface treating agents of Applicants Claim 13. Since Claims 14-26, wherein Claim 26 depends from Claim 25, each depend from Claim 13, Applicants respectfully consider Claims 14-26 to be in condition for allowance.

Double Patenting

The office rejected Claims 13-26 under the judicially created doctrine of obviousness-type double patenting as being allegedly unpatentable over Claims 1-9 of U.S. Patent No. 6,129,955 in view of Christie *et al.* Applicants respectfully traverse the Examiner's rejection, maintaining the Claims 1-9 of U.S. Patent No. 6,129,955 and Claims 13-26 are drawn to distinctly patentable inventions. The third sentence of 35 U.S.C. § 121 prohibits the use of a patent issuing on an application with respect to which a requirement for restriction has been made, or on an application filed as a result of such a requirement, as a reference against any

divisional application, if the divisional application is filed before the issuance of the patent. See MPEP 804.01. Applicants respectfully assert the present invention is a divisional of Serial No. 09/471,520, filed December 23, 1999; which is a CIP of Serial No. 08/874,220, filed June 13, 1997; which is a Divisional of Serial No. 08/548,893, filed October 26, 1995, Abandoned. Further, Applicants respectfully assert the Office required a restriction in an Office Action mailed 1/13/98, Serial No. 08/874,220 to one of the following inventions under 35 U.S.C. § 121:

- I. Claim 22, drawn to an article of manufacture, classified in class 428, subclass 206.
- II. Claims 23-25, drawn to a photoinduced polymerizable cyanate ester composition, classified in class 522, subclass 66.

The Office stated "The inventions are distinct, each from the other because:

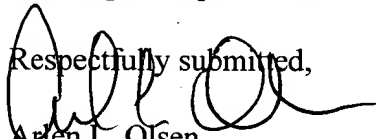
Inventions I and II are unrelated. ... In the instant case the different inventions are drawn to an article of manufacture and a photoinduced polymerizable cyanate ester composition. The article of manufacture involves an integrated circuit chip, a substrate, and a soldered joint made of an encapsulant which is the polymerized product of a cycloaliphatic epoxide and a dispersed phase of particulate silica while Group II has specifics of the composition that are not an epoxide and silica." See the Office action mailed 1/13/98 for Serial No. 08/874,220.

Based on the foregoing, Applicants respectfully assert that Claims 13-26 are in condition for allowance since the rejection of Claims 13-26 as being allegedly unpatentable over Claims 1-9 of U.S. Patent No. 6,129,955 in view of Christie *et al.* under the judicially created doctrine of obviousness-type double patenting was improper. The rejection was improper because 35 U.S.C. § 121 prohibits use of U.S. Patent No. 6,129,955 as a reference because U.S. Patent No.

6,129,955 is a patent issuing on an application, Serial No. 08/874,220, with respect to which a requirement for restriction has been made.

CONCLUSION

Applicants submit that the entire application is in condition for allowance. However, should the Examiner believe anything further is necessary in order to place the application in better condition for allowance, or if the Examiner believes that a telephone interview would be advantageous to resolve the issues presented, the Examiner is invited to contact the Applicants' undersigned representative at the telephone number listed below.

Respectfully submitted,

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Appendix A. Identification of Amended Material

IN THE SPECIFICATION

The following paragraph replaces the paragraph on page 18, line 29:

The cycloaliphatic epoxy resins have a preferred epoxy equivalent weight of from about 50 to about 500, preferably from about 50 to about 250. The cycloaliphatic epoxy resins have a viscosity less than about 1000 cps (centipoise) at 25°C, preferably about 5 to about [900] 900 cps, more preferably about 300 to about 600 cps, and most preferably about 300 to about 450 cps. The cycloaliphatic epoxy resins have a molecular weight of from about 200 to 700, preferably 200 to 500, and a weight per epoxide of 50 to 500, preferably 50 to 300.

The following paragraph replaces the paragraph on page 25, lines 22, 28, 29, 30 and 32:

Preferably, the resin-photoinitiator-filler compositions or blends of the present invention further include a toughening agent to improve the fracture properties of the compositions. The toughening agent is preferably miscible with [of] or capable of forming a stable suspension in the compositions. Further, when added to the compositions, the toughening agent preferably does not interfere with the cationic curing mechanism of the compositions and does not significantly affect the thermal and mechanical properties of the cured resin compositions. To achieve high glass transition temperatures and improve mechanical properties, e.g., toughness, the resin compositions preferably include[s] toughening agents that have options such as thermoplastics, hydroxy-containing thermoplastic oligomers, epoxy or other organic functional reactive-containing thermoplastic oligomers, reactive flexibilizer, rubber, elastomer, or any mixtures thereof. A variety of toughening agents can be used

with thermally or cationic cured epoxy resins, which typically use an amine coreactant [of] or hardener for cross linking. Preferred toughening agents include rubber or elastomers, either as discrete particles or reacted with the epoxy resins, epoxy functionalized flexibilizers, engineering thermoplastics, and amine or hydroxy-terminated thermoplastic oligomers.

The following paragraph replaces the paragraph on page 26, line 4:

The toughening agents and flexibilizers can benefit from high molecular [weight] weight engineering thermoplastics for increasing the toughness of the thermally or radiatively cured epoxy or epoxy-triazine mixtures utilized as binding matrices. Polysulfones such as those available from Amoco Performance Products, Inc. under the trademarks UDEL and RADEL can be dissolved in the epoxy resin-initiator composition to form a viscous homogeneous mixture. After curing, its toughness is significantly superior in comparison with the untoughened resin. Similar results can be obtained with a polyetherimide, which is available from General Electric Company under the trademark ULTEM. Although preferred the thermoplastic is not necessary to be miscible with the triazine or triazine epoxy resin-initiator composition. The fracture toughness of the cured resin can be further improved by adding Nylon 12 and Nylone 6/12 particles, ELF ATOCHEM ORGASO 2001 and ORGASOL 3501, or IMITEC X-902 polyimide particles, even though these materials are so insoluble in the epoxy resin monomer mixture. Other thermoplastics such as, for example, polyamideimides, poly(arylene ethers), polyesters, polyarylates, polycarbonates, polyurethanes etc., are potentially useful as toughening agents in accordance with the present invention. Further examples can be found in "Engineering Plastics" by D.C. Clagett in Encyclopedia of Polymer Science and Engineering, John Wiley and Sons.

The following paragraph replaces the paragraph on page 26, lines 24 and 27:

Engineering thermoplastics are typically end capped with nonreactive functional groups. In accordance with the embodiment of the present invention, the toughening agent is preferably a low molecular weight segment of oligomer of [a] the aforementioned thermoplastics, which contains functional groups capable of reaction with the cyanate or epoxy-cyanate resin during the radiation induced polymerization. Accordingly, thermoplastic materials that have been modified to contain a thermoplastic oligo[v]mer backbone and to have more reactive end groups are particularly useful as the toughening agents. For this purpose, hydroxy-terminated polysulfone oligomers based on the UDELP-1700 polymer backbone can be synthesized at various molecular weights. These materials can be easily blended with the resin monomer-photoinitiator mixture and the resulting compositions are less viscous than those having the same percentage of high molecular weight polymer of similar backbone, but with different end groups. The materials are also effective in increasing fracture toughness of the cured resin. Oligomers with other backbones such as, for example, poly (arylene ethers), polyarylates, and polyester, can also be used. In accordance with the present invention, any of the aforementioned thermoplastics could function as the oligomer backbone.

The following paragraph replaces the paragraph on page 27, lines 9 and 29:

Reactive end groups are capable of reacting with the cyanate-epoxy resin during the cationic polymerization. By way of example, the reactive end groups of the present invention include hydroxy, epoxy, and carboxylate groups. Flexible molecules containing [tow] two or more epoxy groups can also be used as the toughening agents in the present invention. These molecules typically contain long aliphatic groups that act to reduce cross link density in the cured epoxy resin. In

addition to increasing the fracture toughness of the cured resin, the addition of low viscosity flexibilizers can also significantly the overall viscosity of the uncured resin-initiator-flexibilizer mixture. Suitable flexibilizers for the present invention include, but are not limited to, 1,4-butanediol diglycidyl ethers such as those from Shell Chemical Company under the trademark HELOXY MODIFIER 67, neopentylglycol diglycidyl ether such as that from Shell Chemical Company under the trademark HELOXY MODIFIER 107, trimethylol ethane triglycidyl ethers such as those from Shell Chemical Company under the trademark HELOXY MODIFIER 44, dibromoneopentylglycol glycidyl ethers such as those from Shell Chemical Company under the trademark HELOXY MODIFIER 56, propoxylated glycerol polyglycidyl ether such as that from Shell Chemical Company under the trademark HELOXY MODIFIER 84, polypropylene glycol glycidyl ether such as that from Shell Chemical Company under the trademark HELOXY MODIFIER 32, polyglycidyl ether of castor oil such as that from Shell Chemical Company under the trademark HELOXY MODIFIER 505, dimer acid diglycidyl esters such as those from Shell Chemical Company under the trademark HELOXY MODIFIER 71, resorcinol diglycidyl ether such as that from Shell Chemical Company under the trademark HELOXY 59, epoxidized propylene glycol dioleates such as that under the trademark ELF ATOCHEM VIKOFLES 4050, 1,2- ϵ -[r]adecane oxides such as those under the trademark ELF ATOCHEM VIKOFLES 14, internally epoxidized 1, 3-butadiene homopolymers such as those under the trademarks ELF ATOCHEM POLY BD 600 and POLY BD 605, diglycidyl ether, glycidyl glycidates, bis (2, 3-epoxy-2 methypropyl) ether, and polyglycoldiepoxydes such as those from DOW Chemical Company under the trademarks DER 732 and DER 736. Flexible molecules containing two or more hydroxy groups can also be used as the toughening agents in accordance with the present invention. These flexible polyol compounds

contain long aliphatic groups. Useful polyols include E-caprolactone triol such as those from Union Carbide Corporation under the trademarks TONE 0301, TONE 0305, and TONE 0310.

The following paragraph replaces the paragraph on page 28, line 7:

Elast[er]omeric units such as elastomers or rubbers that can be used in the composition of the present invention include, but are not limited to, copolymers of styrene, butadiene, and ethylene or styrene, butylene, and ethylene such as that from Shell Chemical Company under the trademark CRATON RUBBER, butadiene, styrene copolymers, copolymers of butadiene and styrene, butyl rubber, neoprene rubber, and poly (siloxanes). Functionalized versions of these materials are particularly useful. Epoxy resin monomers may be reacted with these materials to form an epoxy terminated elastomer that can be used as toughening agents. Maleic anhydride terminated KRATON rubber, e.g., Fg 1901X from Shell Chemical Company, and epoxy functionalized liquid KRATON rubber, e.g., EXP-206 and EKP-207 from Shell Chemical Company, can also be used as the toughening agents.

The following paragraph replaces the paragraph on page 28, line 24:

It is also advantageous to blend various types of toughening agents or flexibilizers in order to achieved desirable toughness through different toughening mechanisms and to adjust the overall viscosity of a thermoplastics or thermoplastic oligomer dissolved in an epoxy resin monomer. The overall viscosity may be reduced and the toughness may be improved in comparison with using a single toughening agent or flexibilizer. The thermoplastics may separate from the cured epoxy-

cyanate resin to form a two phase morphology while the flexibilizer provides long flexible groups connect cross link sites in the network.

The following paragraph replaces the paragraph on page 28, line 26:

Elastomeric units which are endcapped with reactive functional groups can be used as the toughening agents. For example, fluoridized rubbers and polysiloxanes with terminally functional groups and [hydroxylated] hydroxylated or carboxylated EPDM rubber can also be used as the toughening agents in accordance with the present invention.

IN THE CLAIMS:

13. (AMENDED) A method for encapsulating a solder joint between an integrated circuit chip and a substrate, comprising the steps of:

forming a composition comprising a cyanate ester, a photoinitiator, and dispersed [silica] filler, wherein the filler has been treated with a surface treating agent;

applying an amount of the composition at a thickness sufficient to cover substantially all of the solder joint; and

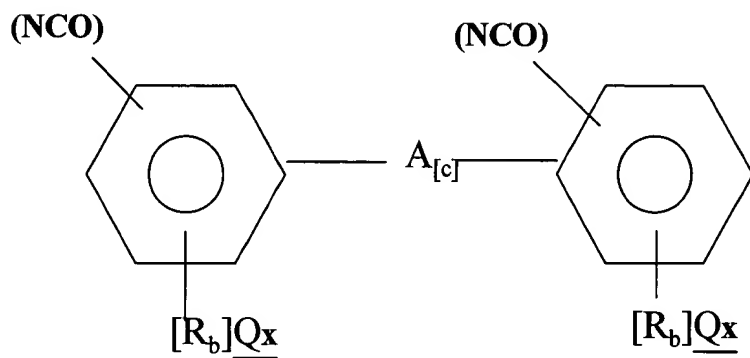
photocuring the composition to reinforce the solder joint.

14. The method of claim 13, wherein the cyanate ester includes at least two cyanate groups and is curable through cyclotrimerization.

15. (AMENDED) The method of claim 13, wherein the cyanate ester [includes] is selected from

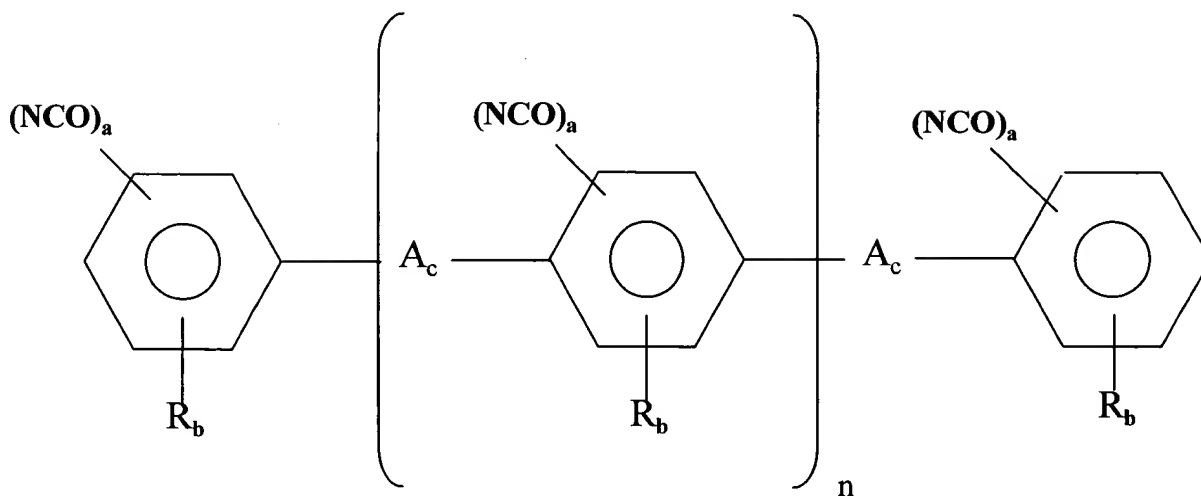
the group consisting of compounds depicted by formulas 1 and 2:

(1)



p.19

(2)



p.20

wherein each a and b independently include integers from 0 to 3, and at least one a is not 0;
 wherein c includes integers from 0 to 1; wherein n includes integers from 0 to 8[, preferably from 0 to 3]; wherein each R is independently selected from the [non-interfering] group consisting of $C_{[1-9]1-6}$ alkyl, aryl, $C_{[1-9]1-6}$ alkaryl, heteroatomic, heterocyclic, carbonyloxy, carboxy, hydrogen, $C_{[1-9]1-6}$ alkoxy, $C_{[1-9]1-6}$ alkenyloxy, $[C_{1-9}]$ propargyloxy, $[C_{1-9}]$ allyloxy, halogen, maleimidyl, glycidyloxy and combinations thereof; wherein x includes integers from 0 to 4; wherein each Q is independently selected from the group consisting of hydrogen, halogens, C_{1-9} alkyl; and wherein A is selected from the group consisting of [oxo, sulfonyl, carbonyl, carboxy, thio, methylene,] C_{1-12} polymethylene, CH_2 , dicyclopentadienyl, aralkyl, aryl, cycloaliphatic, $CH(CH_3)$, SO_2 , O, $C(CF_3)_2$, CH_2OCH_2 , $(CH_2S)_{x=(\text{integers from 0 to } [9])}$, $(CH_2NH)_{x=(\text{integers from 0 to } 9)}$, CH_2SCH_2 , CH_2NHCH_2 , S, $C(=O)$, $OC(=O)$, $OCOO$, $S(=O)$, $OP(=O)$, $OP(=O)(=O)O$, alkylene radicals, $C(CH_3)_2$, and combinations thereof.

16. (AMENDED) The method of claim 13, wherein the cyanate ester is selected from the group consisting of cyanatobenzene 1,3-and 1,4-dicyanatobenzene, 2-tert-butyl-1,4-dicyanatobenzene, 2,4-dimethyl-1,3-dicyanatobenzene, 2,5-di-tert-butyl-1,4-dicyanatobenzene, tetramethyl-1,4-dicyanatobenzene, 4-chloro-1,3-dicyanatobenzene, 1,3,5-tricyanatobenzene, ^{or} 2,2',4,4'-dicyanobiphenyl, 3,3',5,5'-tetramethyl-4,4'-dicyanobiphenyl, 1,3-dicyanatonaphthalene, 1,4-dicyanatonaphthalene, 1,5-dicyanatonaphthalene, 1,6-dicyanatonaphthalene, 1,8-dicyanatonaphthalene, 2,6-dicyanatonaphthalene,

2,7-dicyanatonaphthalene, 1,3,6-tricyanatonaphthalene, bis(4- cyanatophenyl)methane, bis(3-chloro-4-cyanatophenyl)methane, 2,2-bis(4-cyanatophenyl)propane, 2,2-bis(3,5-dichloro-4-cyanatophenyl)propane, 2,2-bis(3,5-dibromo-4- cyanatophenyl)propane, bis (4-cyanatophenyl)ether, bis (p-cyanophenoxyphenoxy)-benzene, di(4-cyanatophenyl)ketone, bis(4-cyanatophenyl)thioether, bis(4-cyanatophenyl)sulfone, tris (4-cyanatophenyl)phosphite, tris(4-cyanatophenyl)phosphate and combinations thereof.

17. The method of claim 13, wherein the photoinitiator is selected from the group consisting of aryldiazonium, triphenylsulfonium, diphenyliodonium, diaryliodosyl and triarylsulfoxonium salts.

18. The method of claim 13, wherein the composition contains about 40% to about 75% by weight dispersed silica.

19. (AMENDED) The method of claim 13, wherein the dispersed [silica is one of] filler includes fused silica and amorphous silica.

20. (AMENDED) The method of claim [19] 13, wherein [the] a particle size of the dispersed [silica includes] filler is less than or equal to 31 microns [or less].

21. (AMENDED) The method of claim 13, wherein a coefficient of linear thermal expansion of the cured composition [includes] is from about 26 to about 39 ppm/degree C.

22. (AMENDED) The method of claim 13, wherein a glass transition temperature of the cured composition [includes] is from about 100 to about 160 degrees C.
23. (AMENDED) The method of claim 13, wherein the composition includes from 1 to 20 parts [and more preferably from 3 to 15 parts] of surface treating agents selected from the group consisting of vinyltrimethoxysilane, vinyltriethoxysilane, N(2-aminoethyl)3-aminopropylmethyldimethoxysilane, 3-aminopropylethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropylmethyl dimethoxysilane and combinations thereof, based on 100 parts of [resin] the cyanate ester.
24. (AMENDED) The method of claim 13, wherein the [composition includes thermally conductive and electrically insulating] filler[s] is selected from the group consisting of silica, Aluminum Oxide, 92% Alumina, 96% Alumina, Aluminum Nitride, Silicon Nitride, Silicon Carbide, Beryllium Oxide, Boron Nitride and Diamond powder.
25. (AMENDED) The method of claim 13, wherein the composition further comprises a toughening agent selected from the group consisting of elastomers, rubber, [epoxy resins] epoxy terminated elastomer, hydroxy-terminated polysulfone oligomers, and combinations thereof.
26. (AMENDED) The method of claim 25, wherein a [molecular weight] viscosity of the toughening agent ^{is} includes from about 500 to about 1,000 centipoise.